

NOTES, ABSTRACTS, AND REVIEWS.

FURTHER MEASUREMENTS OF STELLAR TEMPERATURES AND PLANETARY RADIATION.

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[Author's abstract.]

During the past summer, through the generosity of the Lowell Observatory, Flagstaff, Arizona, who financed this research, a further opportunity was presented to continue the measurements of 1921, relating stellar temperatures and planetary radiation. Especial acknowledgement is due Dr. C. O. Lampland for kindly operating the telescope.

The speaker reported a verification of the estimates presented before this society¹ (the meeting of December 17, 1921) of the temperatures of 16 stars as determined from their spectral energy distribution, which was obtained by means of a new spectral radiometer, consisting of a series of transmission screens and a vacuum thermocouple.

By means of these screens, which, either singly or in combination, had a uniformly high transmission over a fairly narrow region of the spectrum and terminating abruptly to complete opacity in the rest of the spectrum, it was possible to obtain for the first time the radiation intensity in the complete stellar spectrum as transmitted by our atmosphere.

The recent measurements of the spectral radiation components, made principally on the sun, the temperature of which was used as a standard of comparison, verify the previous measurements of stellar temperatures which range from 3000° K. for red, class-M stars, to 12000° K. for blue, class-B stars.

Planetary Radiation.—The thermal radiation emitted from a planet as a result of warming by exposure to solar radiation, including heat which may be radiated by virtue of a possible high internal temperature of the planet itself, is essentially of long-wave lengths 7μ to 12μ . Hence, by means of a 1-cm cell of water, interposed in the path of the total radiation emanating from the planet, this long-wave-length radiation can be separated from the reflected solar radiation, and in this manner a measurement obtained of the energy reradiated. If there is planetary radiation then the water cell transmission will be less than that of direct solar radiation.

It was observed that the water cell transmission of the total radiation emanating from Jupiter is practically the same as that of the direct solar radiation. From this it appears that the outer atmosphere of Jupiter does not radiate appreciable long-wave-length infra-red energy as the result of warming by solar rays, and that the atmosphere is sufficiently thick and opaque to trap all the energy reradiated as the result of warming of its interior by solar radiation, or by internal heating, if the interior of Jupiter is still highly heated.

The radiometric measurements on Venus, Jupiter and Saturn are in good agreement with similar measurements made at Mount Hamilton, Calif., in 1914, showing a decidedly lower transmission of radiation through the water cell, in the case of Venus and Saturn.

The intensity of the planetary radiation increases with decrease in the density of the surrounding atmosphere and (as interpreted from the water cell transmissions)

in per cent of the total radiation emitted, is as follows: Jupiter (0), Venus (5), Saturn (15), Mars (30) and the Moon (80).

The water-cell transmission of the radiations from the southern (50.6 per cent) and northern (53.1 per cent) hemispheres of Mars should be, and are, higher (i. e., the planetary radiation is lower) than that of the radiations emanating from the equatorial (47.3 per cent) region, owing to the depletion of the reradiated energy by the greater air mass. Moreover, the intensity of the planetary radiation from the northern hemisphere of Mars was found to be less than from the southern hemisphere. This is to be expected in view of the observed cloudiness over the northern hemisphere, which is approaching the winter season and hence is at a lower superficial temperature.

The radiometric measurements on Mars are of especial interest in view of the question of the temperature of this planet.

The calculations of Lowell, based on the heat retained, give a mean temperature of 9° C. for the surface; while another calculation gives a temperature of 22° C. He points out that, owing to cloudiness, only 60 per cent of the incident solar radiation is effective in warming the earth, while 99 per cent is effective in warming the surface of Mars.

In a recent discussion in *Popular Astronomy* of climatic conditions on Mars, inferred from phenomena generally observed on the planet, Pickering estimates the mean annual temperature at +20° F. as compared with the mean annual temperature of the earth of +59° F. (15° C.). At night the Martian temperature is below 32° F. (0° C.) and at noon it is perhaps 60° to 70° F. (15° to 20° C.). These estimates are arrived at from the appearance and disappearance of snow and frost during the course of the Martian day and from the fact that snow is never seen on the equator of Martian noon.

The radiometric measurements are in agreement with the calculations of Lowell and with the arguments recently set forth by Pickering, showing a considerable rise in temperature of the surface of Mars.

Probably the most convincing experimental observations of the range of temperature of the moon are those of Langley and Very and, later, those of Very. These measurements indicate inferred effective lunar temperatures ranging from 45° C. to over 100° C. The calculated value, using recent data on the solar constant, indicates a lunar temperature of 82° C. When we consider that 30 per cent of the total radiation emanating from Mars is of planetary origin, as compared with 80 per cent from the moon, and that all the evidence shows that the lunar surface becomes appreciably warmed, it appears that there is also a considerable temperature rise (10° to 25° C.) of the surface of Mars as calculated by Lowell. So, whether or not we accept the view that vegetation can exist on Mars, the radiometric measurements confirm other meteorological data, showing that at Martian noon the snow is melted, which could not happen if the temperature were -39° C., as some have calculated.

As for the views held by some of the possibility of vegetation growing on Mars, much depends upon whether we think of palm trees growing in our Tropics or the mosses and lichens which thrive on the apparently bare piles of volcanic cinders of Arizona and under our Arctic snows.

¹ Philosophical Society of Washington.